

REMARKS/ARGUMENTS

Claims 1-5 have been amended. Claim 6 has been canceled. Claim 7 remains in this application. Claim 8 has been canceled. Claim 9 has been added as new.

The examiner has acknowledged that claims 1-5 have now been amended to correct editorial errors and clear up any matters of form. Claims 6 and 8 have been canceled as being drawn to an embodiment no longer of interest to applicant. Claims 7 and 9 are directed to allowable subject matter.

Claim 1 has been amended for the following reasons:
To clear up any matters of form.

Claim 2 has been amended for the following reasons:
To clear up any matters of form.

Claim 3 has been amended for the following reasons:
To clear up any matters of form.

Claim 4 has been amended for the following reasons:
To clear up any matters of form.


Claim 5 has been amended for the following reasons:
To clear up any matters of form.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned **"Version with markings to show changes made."**

Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

Respectfully submitted,

INVENTOR

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

A new section, lines 1-37, entitled " BRIEF DESCRIPTIONS OF THE SEVERAL VIEWS OF THE DRAWINGS " has been added after the first paragraph on page 4, as indicated in the clean copy:

The following paragraph numbers 001, 002, 0021, 0022 and EXAMPLES starting on page 4 and ending on page 5 have been deleted from the application:

DETAILED DESCRIPTION OF THE INVENTION

~~001 Multi-Axes Tool Compensation at the CNC controller provides CNC machinists using CNC Controllers a convenient method for applying 3D and 5-axis tool compensation in real time as they enjoy now when using the traditional 2D tool comp standards G41 and G42. Up until now CNC controllers have not been technically advanced enough to employ multi-axes tool compensation methods. Using these defined methods of my invention for multi-axes tool compensation, the machine operator now has a pre-defined method to assign 3D and 5-axis tool characteristics at the CNC controller. CNC programmers now have the tools to issue 3D and 5-axis tool comp commands, which have not been available in traditional CNC controllers. The CNC machine operator does not require the assistance of the CNC programmer to re-create a brand new CNC G-code Program with new tool information and definitions when a change is made. My invention allows the CNC machine operator to define the new tools using complex 3D and 5-axis tool compensation algorithms built into the CNC controller. These algorithms also provide for automatic tool gouge avoidance protection.~~

~~002 Description of the Command Usage for Multi-axes Tool Compensation~~

~~0021 The TOOLCOMP command enables 3D and 5-axis tool compensation and has eight possible parameters: OFF, LEFT, RIGHT, 3DCOMP, 3DADJUSTZ, 3DOFFSET, 5AXIS and LLIMIT45. These parameters are usually associated with G40,~~

~~G41, G42, G130, G131, G132 and G135. The compensation value is taken from the tool parameter screen for that specific tool number.~~

~~0022 All tool compensation is preprocessed when the file is loaded into memory. If a tool size is changed or the user edits the G code program to reflect a change in tool comp methods, then the program will automatically reprocess and redraw the G code program. If 3D or 5 axis tool comp is used, the CAD/CAM system will need to include the special codes on each G code line that will need to be compensated. The special codes represent a normalized 3D vector and the L code represents a conical angle measured from the XYZ point to the nearest obstacle from a flat 2D plane. If the user specifies an angle after LLIMIT, then the tool position may be completely omitted in order to automatically avoid gouging. This occurs if the included angle between the vector and the L code is less than the value specified after LLIMIT. The default of LLIMIT is 45 degrees. To turn gouge protection off, specify a zero value after LLIMIT 0. Take caution if the tool size is increased at the control, which is larger than the original. An obstacle may exist beyond the diameter of the original tool size that may result in an unforeseen gouge. If the tool size is decreased from the original size, then there may be some extra stock left in tight corners since possible gouges were originally figured for a larger tool.~~

EXAMPLES:-

TOOLCOMP OFF	Turns all compensation off.
TOOLCOMP LEFT	Comps in 2D to the left.
TOOLCOMP RIGHT	Comps in 2D to the right.
TOOLCOMP 3DCOMP	3D comp based on vector and gouge parameter.
TOOLCOMP 3DADJUSTZ	3D comp lifts Z axis only but keeps X,Y.
TOOLCOMP 3DOFFSET	3D parallel offset only based on vector and no 'gouge parameter.
TOOLCOMP 5AXIS	5 axis comp based on vector and gouge parameter.
TOOLCOMP LLIMIT45	Give angle which will specify a gouge to omit tool 'position.

New rewritten content, lines 3-306, has replaced the entire content of the section entitled "DETAILED DESCRIPTION OF THE INVENTION," beginning on page 4, as indicated in the clean copy.

In the Claims:

Claim 1 has been amended as follows:

Claim 1 (Amended): I claim a technology element that calculates Multi-Axes Tool Compensation technology handles all tool compensation internal to a central mathematical set of algorithms in memory of the CNC controller which ties all of the provided set of commands together as described in the steps and elements of which comprise:

- a. The user setting his or her preferences for the values or amounts to compensate into boxes on an operator screen, such as the example screen in FIG 1. for the boxes labeled tool size, horizontal offset, vertical offset, tool wear, corner radius, bottom angle, side angle and tool length. These interact with the G code program and other values optionally inputted or gathered as variables when the math calculations are performed.
- b. The user must repeat the steps in Claim 1.a setting and entering his or her preferences for each tool description. There is no limit to the number of tools, machine types or tool shape combinations to enter.
- c. An industry standard G Code program, as in FIG 9., containing tool positions based on non-compensated original part geometry data, interact with the Multi-Axes tool compensation calculations when they are applied. These are the original tool positions that the user supplies in which the calculations are applied. These interact with values provided on the tool parameter screen. For each multi-axes X,Y,Z,A,B,C value entered in the G Code program, the controller will calculate a compensated value based on the amounts entered into the tool parameter screen as in the example screen in FIG 1.
- d. A set of optional text entered commands are provided to interact and be directly entered onto the operator screen to override or toggle features on/off and adjust values:

<u>TOOLCOMP OFF</u>	<u>'Turns all compensation off.</u>
<u>TOOLCOMP LEFT</u>	<u>'Comps tool in 2D to the left.</u>
<u>TOOLCOMP RIGHT</u>	<u>'Comps tool in 2D to the right.</u>
<u>TOOLCOMP 3DCOMP</u>	<u>'3D comp based on vector and gouge parameter.</u>
<u>TOOLCOMP 3DADJUSTZ</u>	<u>'3D comp lifts Z axis only but keeps X,Y.</u>
<u>TOOLCOMP 3DOFFSET</u>	<u>'3D parallel offset only - based on vector and</u> <u>'no gouge parameter.</u>
<u>TOOLCOMP 5AXIS</u>	<u>'5-axis comp based on vector and gouge parameter.</u>
<u>TOOLCOMP LLIMIT45</u>	<u>'Give angle which will specify a gouge to omit tool.</u>

- e. A multi-axes tool positioner in a tool holder mounted to a machine's spindle cuts the part as shown in FIG 7 and FIG 8.

- f. The process of gathering the user-entered information, preferences, values, amounts, on/off options on the operator screen as in FIG 1. or as entered by optional text commands as in Claim 1.d interact with the original tool positions as provided in the G code program, as in FIG 9, to provide the mathematical variables when processed by a set of described central mathematical routines internal to the CNC Controller as outlined in the DETAILED DESCRIPTION OF THE INVENTION section. The various methods for gathering the information are incidental as to how the central set of math routines that perform these calculations receive them.

Claim 2 has been amended as follows:

Claim 2 (Amended): I claim a Multi-Axes Tool Compensation element according to Claim 9, which automatically calculates does tool gouge avoidance protection internal to the CNC controller's central set of math routine algorithms as shown in FIG 5 Dim "E" Item 7.

Claim 3 has been amended as follows:

Claim 3 (Amended): I claim a method pertaining to Claim 1 for Multi-Axes Tool Compensation, which automatically contains algorithms to lift the tool to safe positions or skip the move when necessary by determining if the LLIMIT parameter, as shown in FIG 5 Dim "E" Item 7, is in violation of any surrounding obstacles as determined by a user-defined variable value as enter on the operator screen in FIG 1.

- a. This claim is an alternative claim method of calculating tool gouge avoidance and tool protection as outlined in Claim 2.

Claim 4 has been amended as follows:

Claim 4 (Amended): I claim a method pertaining to Claim 1 which ~~Multi-Axes Tool Compensation~~ does not depend on the CNC programmer to re-define tool position coordinates when the tool characteristics change.

Claim 5 has been amended as follows:

Claim 5 (Amended): I claim a method pertaining to Claim 1 which ~~Multi-Axes Tool Compensation~~ allows the CNC machine operator[[s]] to override the pre-defined tool characteristics by entering or setting defined values as described by and shown in FIG 1 on the operator screen.

Claim 6 has been canceled.

Claim 7 remains in this application.

Claim 8 has been canceled.

Claim 9 has been added as new as follows:

Claim 9 (New): I claim an algorithm element according to Claim 1 which does not store or pass the compensated positions by geometry alone but rather expands the intelligence of each calculation for compensated tool positions based on an artificial intelligence algorithm element.

- a. The artificial intelligence algorithm element is actually a live, real-time, ever-changing database in the machine's memory that remembers by learning from what the machine can and cannot do. The database is a storage of events, variables as an internal list of conditions and positions kept in standard random access memory as outlined by the various variables used by the central set of math algorithms.